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SURGICAL INSTRUMENT, SUPPORT EQUIPMENT, AND SURGICAL ROBOT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Patent Application No. 10-2012-0125086, filed on Nov. 6, 2012, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

One or more embodiments of the present disclosure relates to a surgical instrument, support equipment for supporting the surgical instrument, and a surgical robot system comprising the support instrument and support equipment.

2. Description of the Related Art

Because minimally invasive surgery using a surgical robot has received a great deal of attention in recent years, much research has been performed in this area and associated developments have largely occurred. A surgical robot may include a passive arm that is manually operated at a preparation stage before a surgical operation is performed and an active arm that is operated by a surgeon. The active arm includes a surgical instrument that is inserted, for example, into the abdominal cavity or a joint region of a patient in order correct various medical problems.

For a smooth and efficient surgical operation, the surgical instrument is required to have a high operating force, a large workspace, and a dexterous motion with a high degree of freedom. However, it is difficult to embody such a surgical robot system satisfying the above requirements. In particular, satisfying these requirements is quite difficult for a single port surgical robot system for performing a surgical operation through a single path (opening).

SUMMARY

A surgical instrument that may have a large workspace and a high operating force is provided.

Support equipment that supports the surgical instrument and controls movements of the surgical instrument is provided.

Support equipment that may allow a surgical instrument to move around a remote center of motion (RCM) is provided.

A surgical robot system including the above-described surgical instrument and support equipment is provided.

Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

According to an aspect of the present inventive concept, a surgical instrument includes an extension portion having a surgical tool at an end thereof, and a head portion connected to the extension portion and actuating the surgical tool. In the surgical instrument, the extension portion includes a first extension portion connected to the head portion, a second extension portion having an elbow joint portion that is bending-actuated by a rigid rod that is reciprocated in a lengthwise direction by the head portion, and a connection portion connecting the first and second extension portions at an angle.

The surgical instrument may further include a rigid main rod extending from the head portion toward the first extension portion and reciprocated in a lengthwise direction by a motor,

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and a flexible rod disposed in the connection portion and having one end portion and other end portion respectively connected to the rigid rod and the main rod, the flexible rod being reciprocated by the main rod, performing a rigid motion in a lengthwise direction, and being able to bend.

The connection portion includes a first guide that is arranged at least one of an inner portion and an outer portion of the flexible rod in a bending direction to guide the flexible rod.

The first guide may be of a roller type and may be supported on the connection portion to be capable of rotating in rolling contact with the flexible rod.

The surgical tool may be actuated by a wire actuation method, and the first guide may divide an inner space of the connection portion into a space where a wire for actuating the surgical tool is arranged and a space where the flexible rod is arranged.

The connection portion may be a second guide that is arranged at least one of opposite sides in a direction perpendicular to the bending direction of the flexible rod to guide the flexible rod.

The elbow joint portion may be rolling actuated.

The elbow joint portion may include a first arm connected to the connection portion, a second arm connected to the first arm to be capable of pivoting around a pitching shaft, and a joint link having one end portion connected to the second arm at a position spaced apart from the pitching shaft of the first arm and the other end portion to which the rigid rod is connected, wherein the second arm is bending actuated with respect to the first arm.

According to another aspect of the present inventive concept, support equipment includes at least one surgical instrument, a base member having an insertion area, and at least one movable member supporting the surgical instrument and installed on the base member to be capable of moving around the insertion area.

The support equipment may further include a rigid main rod extending from the head portion to the first extension portion and being reciprocally actuated by a motor in a lengthwise direction, and a flexible rod disposed at the connection portion, having one end portion and other end portion respectively connected to the actuation rod and the main rod, being reciprocally actuated by the main rod, performing a rigid motion in a lengthwise direction, and being capable of bending.

A first guide may be arranged at least one side of an inner portion and an outer portion of the flexible rod in a bending direction and may guide the flexible rod.

The first guide may be a roller type and may be supported on the connection portion and rotating in rolling contact with the flexible rod.

The elbow joint portion may be rolling actuated.

The elbow joint portion may include a first arm connected to the connection portion, a second arm connected to the first arm to be capable of pivoting around a pitching shaft, and a joint link having one end portion connected to the second arm at a position spaced apart from the pitching shaft of the first arm and the other end portion to which the rigid rod is connected, wherein the second arm is bending actuated with respect to the first arm.

The first extension portion may be connected to a side surface of the head portion facing a movement center axis of the movable member.

The first extension portion may be extended from the head portion toward the movement center axis.

The support equipment may include a pivot member on which the surgical instrument is installed is installed on the